DISSOLVING OF SULPHIDE MINERALS BY ELECTRICAL DISCHARGES IN WATER

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SUMMARY:

In case of high voltage electrical discharges in liquid, the electrical energy of capacitor battery turns to mechanical power of high speed expanding discharge channel. The energy of low temperature plasma is emited as waves of pressure, which at definite distance from the walls of the discharge channel forms a shock wave, as well as electromagnetic and light radiation with high intensity.

The passing of shock waves from liquid phase to solid phase attends arising of strains, that provokes destroying of the solid. Besides, the solid is under the action of cavitation that appears after closing of caverns behind the shock wave profile. By the action of light reactions take place, similar to that, taking place by pulsradiolisis:

$$H_2O \rightarrow H_2O^+ + e^- \quad (1)$$

$$H_2O \rightarrow e^- \quad H_2O^- \quad (2)$$

$$H_2O^- \rightarrow O^- + 2H \quad (3)$$

Conditions for initiation and speed up of oxidation processes occurs. The high temperature of the channel, as well as processes of ionization and dissociation, taking place init, are important factors too. The rate of dissolving is limited by two factors: the rate of solid-solvent interaction and the rate of flusion. In case of electrical discharge in water and naturelly un soluble minerals, we wil Consider the rate of oxidation as rate of interaction. From the equation

$$\frac{dn}{dt} = q \frac{I^2}{rt} \frac{C_1 - C_2}{\delta}$$

where n is the nomber of moles of dissolved solid

q - the surface area of solid

C_1-C_2 - the change of concentration at distance δ from the surface follows, that the rate of diffusion is determined by the concentration gradient, the speed of particles and the area of the surface. In case of electrical discharge in water conditions for maximum of all three factors occurs. The melting of material is accompanied by intense stiring and moving of liquid medium with high relative speed, that takes the productions of dissolving away from the solid surface. As to the rate of oxidation, it is determined by the presence of oxidative agents, products of decomposition of water and raise of water temperature as result of heat transfer from the discharge channel.

EXPERIMENTAL EQUIPMENT

A high voltage puls generator has been used, consisting of high voltage rectifier, capacitors battery and ruled discharger. The discharge Camera was of spherical tipe with volum of 300 ml. The discharge space is in the centre of the sphere. The suspension circulation has been realized by diaphragm pump. The experiments have been performed at conditions followed:

electrical tension between electrodes - 30 kV
discharge frequence - 10 Hz
puls energy - 120, 360 and 500 J

EXPERIMENTAL DATES

The experiments have been performed with samples of pure minerals, having 100% 0-25 mm granulometry. The change of ion composition of liquid is criterium of dissolving of minerals. The experimental dates are presented in Tabl. 1, 2 and 3.

Tabl. 1. Dissolving of $CuFeS_2$, ε = 360 J

nomber of pulses	pH	E_h [mV]	SO_4^{-2} [mg/l]	Cu^{+2} [mg/l]
75	6,0	- 95	65,4	25,8
150	5,5	-130	221,4	68,4
225	5,0	-140	397,0	125,1
375	4,4	-170	757,0	219,5

Tabl. 2. Dissolving of FeS_2, ε = 360 j

Nomber of pulses	pH	E_h [mV]	SO_4^{-2} [mg/l]
75	6,5	+400	527,1
150	6,0	+346	639,6
225	5,4	+285	751,2
375	4,2	+265	922,5

Tabl. 3. Dissolving of PbS, ε = 360 j

Nomber of pulses	pH	E_h [mV]	SO_4^{-2} [mg/l]
75	6,7	-200	48,4
150	6,5	-195	63,9
225	6,1	-185	77,9
375	5,6	-160	97,9

In Tabl. 4 results of dissolving of minerals by various energies of pulses are presented.

Tabl. 4. Dissolving of minerals by various energies of pulses

Nomber of pulses	ε [j]	$CuFeS_2$		FeS_2	PbS
		SO_4^{-2} [mg/l]	Cu^{-2} [mg/l]	SO_4^{-2} [mg/l]	SO_4^{-2} [mg/l]
375	120	412,3	108,7	641,7	65,5
375	360	757,0	219,5	992,5	97,9
375	500	1018,4	315,8	1215,4	120,3

Fig. 1. Presents a diagram, showing the rate of dissolving as function of discharge nomber.

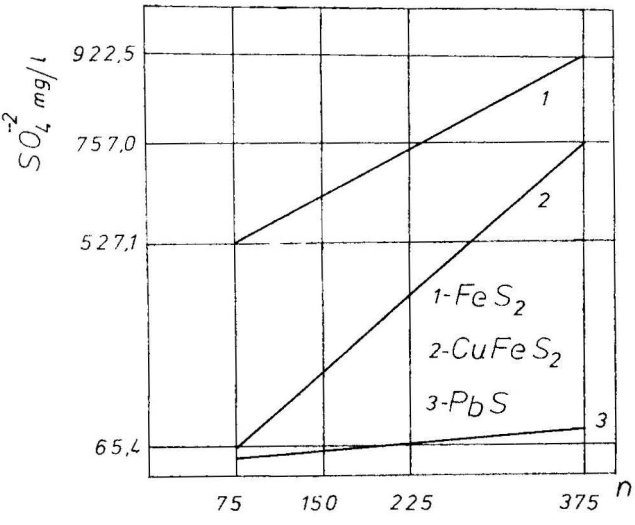

Fig. 1. Rate of dissolving of minerals by energy of 360 j.

DISCUSSIONS

It is evident from the dates, that dissolving of minerals is of relation with the nomber and energy of pulses. The rate of $CuFeS_2$ is the highest one. They suppose, that recombination of active radicals take place, as well as interaction between active radicals and solid components, changing this way the ion composition of liquid. In case of treating pure minerals with electrical pulses, the oxidation processes runs quicly, because of active radicals-fresh solid surfaces interaction. The runing of reactions followed is possible [1]:

$$PbS + 6H_2O \rightarrow Pb(OH)_2 + SO_4^{-2} + 10H^+ + 8e \quad (4)$$

$$PbS + H_3O^+ \rightarrow (PbS)^- + H_2O + H \quad (5)$$

$$(PbS)^- + H_2O_2 \rightarrow PbSHO_2 + H \quad (6)$$

$$PbSHO_2 + HO_2 \rightarrow PbSO_3 + H_2 \quad (7)$$

The treating of $CuFeS_2$ and FeS_2 has been followed by secretion of H_2S. The runing of reactions followed is possible:

$$2CuFeS_2 + 8H_2O \rightarrow Cu^{+2} + Fe^{+2} + 2HSO_4^{-1} + 14H^+ + 16e \quad (8)$$

$$CuFeS_2 + 2Fe_2(SO_4)_3 + 6O_2 + 4H_2O \rightarrow 2CuSO_4 + 4FeSO_4 + 4H_2SO_4 \quad (9)$$

$$CuFeS_2 + H_2SO_4 = CuSO_4 + FeSO_4 + 2H_2S\uparrow \quad (10)$$

The falling of pH of solutions is due to H_2SO_4 formed. The change of redoxpotential proofs the presence of oxidative medium in the Camera.

With the energy used we don't state, that this method is useful in practice as a technology for direct leaching of mineral components from ores. As has been shown however in our latest investigations, as well as in [1], the redokcy processes in the pulp leads to changing of flotation properties of minerals, which could be useful in flotation. The application of electrical discharges in water for dissolving of gypsum and aluminium slags is well known [2] [3].

LITERATURE:

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